SECTION 16100
RACEWAYS, BOXES, AND CABINETS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Raceways include the following:

1. Rigid metal conduit.
2. Polyvinyl chloride (PVC) externally coated rigid steel conduit.
3. Electrical metallic tubing (EMT).
4. Flexible metal conduit.
5. Liquid-tight flexible conduit.
6. Rigid nonmetallic conduit.
7. Wireway.

C. Boxes, enclosures, and cabinets include the following:

1. Device boxes.
2. Outlet boxes.
3. Pull and junction boxes.
4. Cabinets and hinged cover enclosures.

D. Related Sections: The following Sections contain requirements that relate to this Section:

1. Section 16050 - Basic Electrical Materials and Methods.
2. Section 16170 - Equipment Connections.
3. Section 16140 - Wiring Devices for devices installed in boxes.
4. Section 16120 - Wires and Cables.

5. Section 07620 - Sheet Metal Flashing.

6. Section 09900 - Painting.

1.02 SUBMITTALS

A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product data for surface raceway, wireway and fittings, hinged cover enclosures, and cabinets.

1.03 QUALITY ASSURANCE

A. Comply with NFPA 70 "National Electrical Code" for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

C. Comply with NECA "Standard of Installation."

D. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering Products that may be incorporated in the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide Products by of one of the following:

1. Metal Conduit and Tubing:

a. Clifton.
b. Alflex Corp.
c. Allied Tube and Conduit, Grinnell Co.

d. General Electric.
e. Triangle PWC, Inc.
f. National Walker.

2. Nonmetallic Tubing and Conduit:

a. Carlon.
b. Electri-Flex Co.
c. Hubbell, Inc., Raco, Inc.
d. Thomas & Betts Corp.

3. Conduit Bodies and Fittings:

a. Emerson Electric Co., Appleton Electric Co.
b. Carlon.
c. Hubbell.
d. General Signal, O-Z/Gedney Unit.

4. Wireway:

a. Hoffman Engineering Co.
b. Keystone/Rees, Inc.
c. Square D Co.

5. Boxes, Enclosures, and Cabinets:

a. Erickson Electrical Equipment Co.
b. Hoffman Engineering Co., Federal-Hoffman, Inc.
c. Hubbell Inc., Killark Electric Manufacturing Co.
d. General Signal, O-Z/Gedney.
e. Raco, Inc., Hubbell Inc.
f. Square D Co.
g. Thomas & Betts Corp.

2.02 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1.

B. Rigid Aluminum Conduit: ANSI C80.5.

C. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

D. Electrical Metallic Tubing and Fittings: ANSI C80.3 with set-screw or compression-type fittings.

E. Flexible Metal Conduit: Zinc-coated steel.

F. Liquid-tight Flexible Metal Conduit: Flexible steel conduit with PVC jacket.

G. Fittings: NEMA FB 1, compatible with conduit/tubing materials.

2.03 NONMETALLIC CONDUIT AND TUBING

A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2, Schedule 40 or 80 PVC.

B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material. All 45ı and 90ı bends shall be rigid galvanized steel elbows with adapters to non-metallic conduit. Steel shall be painted with one solid continuous coat of heavy-bodied zinc paint.

2.04 WIREWAYS

A. Material: Sheet metal sized and shaped as indicated.

B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireway as required for complete system.

C. Select features where not otherwise indicated, as required to complete wiring system and to comply with NEC.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.05 OUTLET AND DEVICE BOXES

A. Galvanized pressed steel to suit the device or outlet. No box shall be smaller than 4" square or octagon. Those containing 1" conduit or larger shall be 4-11/16" square minimum. Multiple gang boxes shall be 2-1/8" deep maximum. For boxes four gang and over, 2-1/2" deep sectional switch boxes may be used.

B. Sheet Metal Boxes: NEMA OS 1.

C. Cast Metal Boxes: NEMA FB 1, type FD, cast feralloy box with gasketed cover.

2.06 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1.

B. Cast Metal Boxes: NEMA FB 1, cast aluminum with gasketed cover.

2.07 CABINETS AND ENCLOSURES

A. Hinged Cover Enclosures: NEMA 250, steel enclosure with continuous hinge cover and flush latch. Finish inside and out with manufacturer's standard enamel.

B. Cabinets: NEMA 250, type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

2.08 RACEWAYS AND FITTINGS

A. Usage: (Applies to telephone and CATV systems raceways where required).

1. Interior – Exposed:

   a. Higher than 8 feet above finish floor: EMT, rigid steel or rigid aluminum.
   b. Lower than 8 feet above finish floor: rigid steel or protected EMT.

2. Interior - Concealed:

   a. Above floor slab: EMT, rigid steel, rigid aluminum.
   b. In or below floor slab: PVC, or wrapped rigid steel.

3. Stub-ups: coated or wrapped rigid steel. PVC is permitted if encased in concrete.

4. Exterior - Exposed:

   a. Below 12'-0" - Rigid steel. Aluminum where permitted by the Engineer.
   b. Above 12'-0" - Rigid, IMC or EMT.

5. Exterior - below grade: PVC or other utility approved raceway for utility runs. (Material must be specifically approved by utility company).

B. Materials: All bends in raceway over 1" in diameter shall be factory made.

1. Rigid Metallic: Full weight with threaded fittings conforming to industry standards. Rigid conduit in contact with earth or in concrete slabs must be PVC coated or have two wrappings of Pabco wrapping.

   a. Steel Conduit: Protected inside and outside by galvanizing or sherardizing. By Triangle, National Walker, Clifton, General Electric, Rome or Republic. Stub-ups shall be coated with two coats of asphaltum base paint or PVC coating (cover exposed threads and couplings).

b. Aluminum conduit and fittings: Shall conform to industry standards. Fittings and same material as conduit. By Reynolds or Kaiser.

2. Electric metallic tubing (EMT): Protected inside and outside by galvanizing or sherardizing. 4" diameter maximum. Same manufacturers as for rigid steel conduit.

   a. Couplings and Connectors: 1-1/4" and smaller shall be set-screw or threaded compression type, 1-1/2" and larger shall be compression type. Connectors must have insulated throats. All fittings by: Duro, Thomas & Betts, or Steel City.

3. Flexible conduit: National Flexsteel or American Brass. Where exposed to weather use American Brass. "Sealtite" type UA, complete with waterproof fittings. Provide ground wire unless UL approved for ground continuity. Flexible conduit shall be limited to 6'-0" lengths for fixture connection and 4'-0" lengths for HVAC connection.

4. PVC conduit: Schedule 40 polyvinylchloride high (density) impact type two with factory-made bends, couplings and fittings, as manufactured by Carlon or Certaintee. 90 degree bends and stub-ups must be encased in concrete or rigid galvanized steel elbows must be used. Use of PVC is subject to local code authority having jurisdiction.

5. MC Cable: Factory assembled of one or more conductors, each individually insulated and enclosed in a flexible rib aluminum sheath. Conductor shall be rated THHN for sized #8 through #12 in 2 to 4 conductors only. U.L. listed copper conductors. Corra/Clad by Coleman Cable Systems, Inc. only.

   a. Fittings shall be standard metallic connectors approved for use with MC cable.
   b. This wiring method is subject to the local code authority having jurisdiction. (Do not use if not permitted by city code.)

C. Raceway Supports and Fasteners:

1. Individual raceway: Fastened with one-hole malleable straps or pipe-hangers and 3/8" rod. Unistrut or Kindorf.

2. Multiple raceway runs: Unistrut or Kindorf trapeze bar channels suspended by 3/8" steel rods. Fasten conduit to trapeze with clamps. Use patented hangers where applicable.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 WIRING METHODS

A. Outdoors: Use the following wiring methods:

1. Exposed: Rigid metal conduit.

2. Concealed: Rigid metal conduit.

3. Underground, Single Run: Rigid nonmetallic conduit.

4. Underground, Grouped: Rigid nonmetallic conduit.

5. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquidtight flexible metal conduit.

6. Boxes and Enclosures: NEMA Type 3R or Type 4.

B. Indoors: Use the following wiring methods:

1. Connection to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Flexible metal conduit, except in wet or damp locations use liquidtight flexible metal conduit.

2. Damp or Wet Locations: Rigid steel conduit.

3. Exposed: Electrical metallic tubing.

4. Concealed: Electrical metallic tubing.

5. Boxes and Enclosures: NEMA Type 1, except in damp or wet locations use NEMA Type 4, stainless steel.

3.03 CONDUIT SIZE

A. Minimum conduit sizes shall be the following unless otherwise noted:

1. Under slab and underground: Minimum 1" c.

2. All conduit home runs to panel: Minimum 3/4" c.

3. All other conduit: Minimum 1/2" c.

3.04 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

B. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.

C. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

D. Install raceways level and square and at proper elevations. Provide adequate headroom.

E. Complete raceway installation before starting conductor installation.

F. Support raceway as specified in Division 16 Section "Basic Materials and Methods".

G. Use temporary closures to prevent foreign matter from entering raceway.

H. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

I. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

J. Use raceway fittings compatible with raceway and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, except as otherwise indicated.

K. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions, except as otherwise indicated.

L. Conduit is not permitted to be embedded within concrete slabs. Route schedule 40 PVC conduit a minimum of 8" below slab.

M. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

    1. Run parallel or banked raceways together, on common supports where practical.

    2. Make bends in parallel or banked runs from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.

N. Join raceways with fittings designed and approved for the purpose and make joints tight.

    1. Make raceway terminations tight. Use bonding bushings or wedges at connections

subject to vibration. Use bonding jumpers where joints cannot be made tight.

2. Use insulating bushings to protect conductors.

O. Tighten set screws of threadless fittings with suitable tool.

P. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.

Q. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

R. Install pull wires in empty raceways. Use No. 14 AWG (1.6 mm) zinc-coated steel or monofilament plastic line having not less than 200-lb (90 kg) tensile strength. Leave not less than 12 inches (300 mm) of slack at each end of the pull wire.

S. Telephone and Signal System Raceways 2-Inch Trade Size (Size 53) and Smaller: In addition to the above requirements, install in maximum lengths of 150 feet (45 m) and with a maximum of two 90-deg bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.

T. Install raceway sealing fittings according to the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:

1. Where conduits pass from warm locations to cold locations, such as the boundaries of air-conditioned spaces.

2. Where otherwise required by the NEC.

U. Stub-Up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor. Install a 4-inch square box and/or flex connect to the equipment. Be sure stub up is a minimum of 12-inches from equipment electrical connection point to allow for flexible metal conduit bends. Flexible metal conduit may be used 6 inches (150 mm) above the floor. Where equipment connections are not made under this Contract, install screwdriver-operated threaded flush plugs flush with floor.

V. Flexible Connections: Use maximum of 6 feet (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission,

or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations and beneath all product cases. Install separate ground conductor across flexible connections.

W. Install hinged cover enclosures and cabinets plumb. Support at each corner.

X. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

3.05 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touch-up coating recommended by the manufacturer.

3.06 CLEANING

Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION